Space Weather Technical Forecast

Issued on Wednesday, 17 May 2023 at 01:14 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of R1/R2 radio blackouts, perhaps rising after midweek. Slight chance (10%) of G1 minor storm days 3 and 4 due to arrival of fast wind from a coronal hole.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High over the last 24 hours, with the largest event an M9.6 flare, which was observed at 16/1643 UTC, originating from around the southeast limb (probably from Ex-3288) and produced an R2 Radio Blackout. This region is expected to rotate onto the visible disc in the next 24 hours. Otherwise, X-ray activity has been confined to minor C-class flares. There are currently six numbered sunspot regions on the visible disc, with two unnumbered regions. AR3305 remains the largest and most complex region on the disc, which has shown some growth in its trailing portion. However, this region has not shown any significant flare activity in the last 24 hours, and appears to be relatively stable, despite its Beta/Dai classification.

Surprisingly, a very faint CME has emerged off the SE limb following the recent M9.6 flare, which is yet to be analysed. However, coincidently a partial halo CME emerged off the north and west limb following the aforementioned M9.6 flare, which has been analysed and is considered to be far-sided, with no Earth-directed component. The partial halo CME may be associated with the recently departed AR3296, which is now on the far-side. No Earth-directed CMEs have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR at L1, was Slightly Elevated through the period, between 450-500km/s, although the mechanism for this is not certain, although possibly a weak connection with the high latitude CH02/+. Phi angle was mostly positive (away from the Sun) with brief orientations to negative (towards the Sun). The solar wind density was average throughout. The IMF was also at background - at or below 7nT, while the north-south component varied between -5 and +6nT. The net effect of the above solar wind measures was for Quiet to Unsettled geomagnetic activity.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as measured at GOES16, became slightly elevated following the M9.6 flare, but remained well below the active S1/minor storm threshold. High energy electron flux (greater than 2MeV), as measured at GOES16, was mostly within Normal Background levels. The 24-hour integrated fluence has been well below Active levels. At 17/0001UTC, 2.17e6 integrated pfu was recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity will be initially Low, with a Chance of becoming Moderate after midweek UTC, with the expected arrival of a CME-producing sunspot region over the southeast limb, with no significant regions departing off the disc.

Solar Wind / Geomagnetic Activity: No CMEs feature in the four-day forecast.

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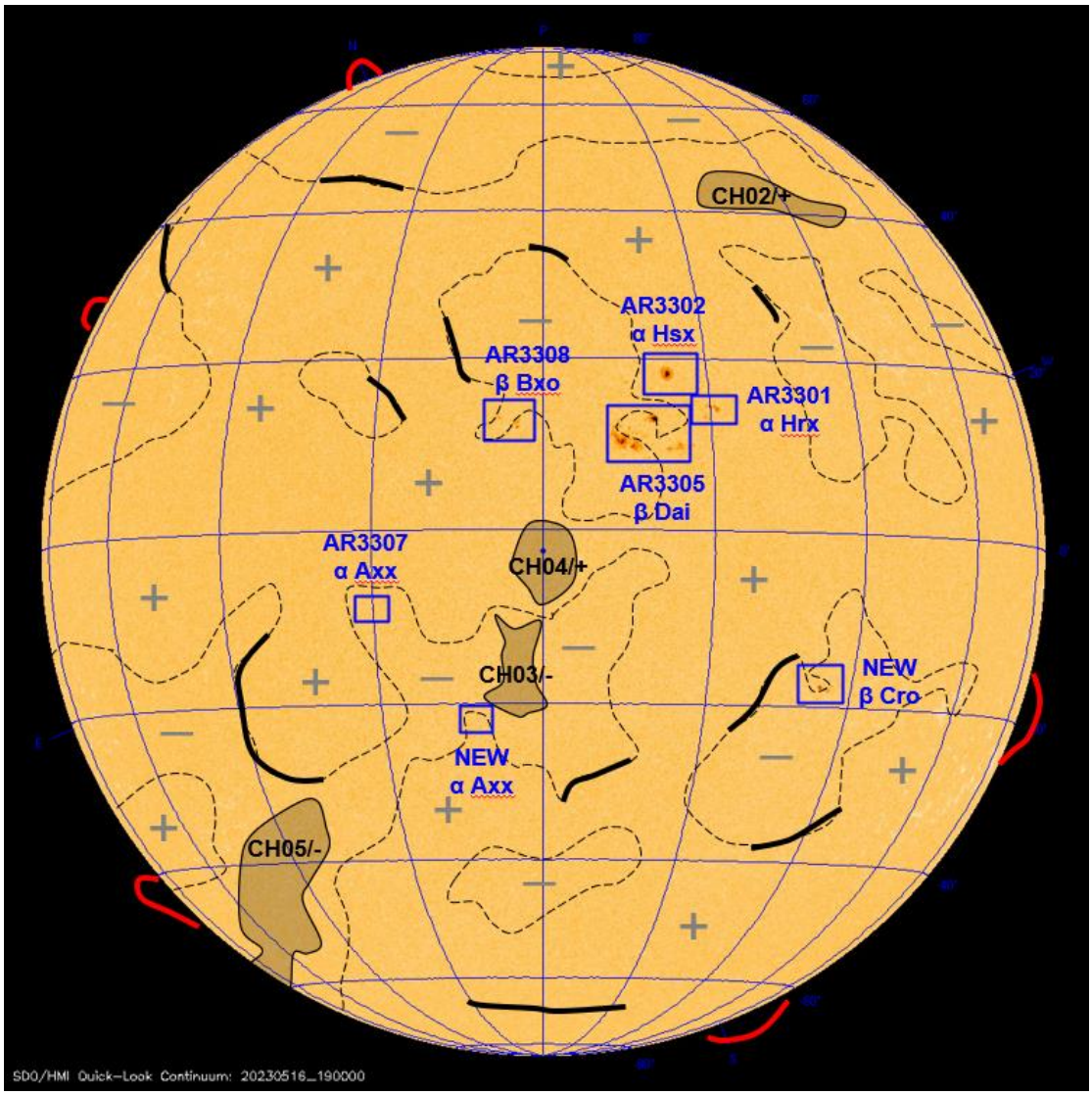
Beyond the possible current marginal influence of CH02, the only coronal hole fast wind due in the four days is CH03/-, which is likely to arrive on Day 3 (19 May). Geomagnetic activity is expected to be mostly Quiet during the coming days, although may increase to Unsettled or Active levels by days 3 and 4 (19-20 May) due to the fast wind from CH03, with a Slight Chance of G1/Minor Storm interval.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux has a Slight Chance of reaching the threshold on Day 1 (17 May) in respond to the recent M9.6 flare. Otherwise, most likely to remain at near Background levels through the period. High energy (greater than 2MeV) electron flux is expected to persist at mainly Normal Background levels. The associated 24-hour fluence is forecast to persist below the Active threshold.

Figure 1. Solar Analysis Valid 16/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs currently feature in the four-day forecast, with the final of the three possible glancing blows (from 11, 12 and 13 May CMEs) now overdue and in all likelihood either missing Earth (as expected per the Enlil deterministic run), else being so late as to be non-impactful in terms of geomagnetism.

Earth had been expected to be in a slow wind regime in the current period, however the solar wind speed is perhaps surprisingly high should this be the case in the upper 400s of km/s, and may better be explained by a tenuous connection to the high latitude CH02/+. This is obviously marginal for being able to affect Earth, which could help explain the drifting phi angle, although this is conjectural.

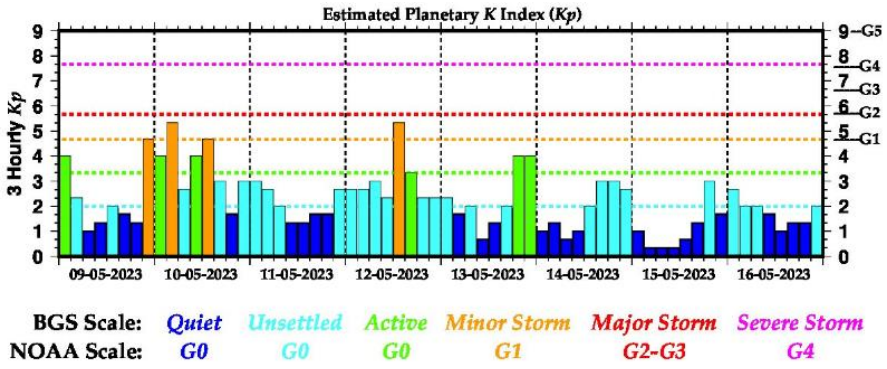
In the expected absence of CMEs, the sole driver of geomagnetic activity beyond the current dalliance with CH02 is expected to be CH03/-, which MOSWOC Enlil signals as arriving on or around day 4 (19 May), with speeds of around 500km/s at peak. This is a persistent feature, however its last pass was completely swamped by the effects of the CME-driven G4 Severe Geomagnetic Storm, and as such its recent capabilities are untested. Having said this, because we are now nearing the solstice, the effects of this feature are nevertheless expected to be suppressed, with perhaps a Slight Chance of a G1/minor storm, in the peak risk for the period as a whole.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: BGS estimated Planetary K index (Kp) – shows mostly Quiet conditions at present.



Radio Blackouts - X-Ray Flares:

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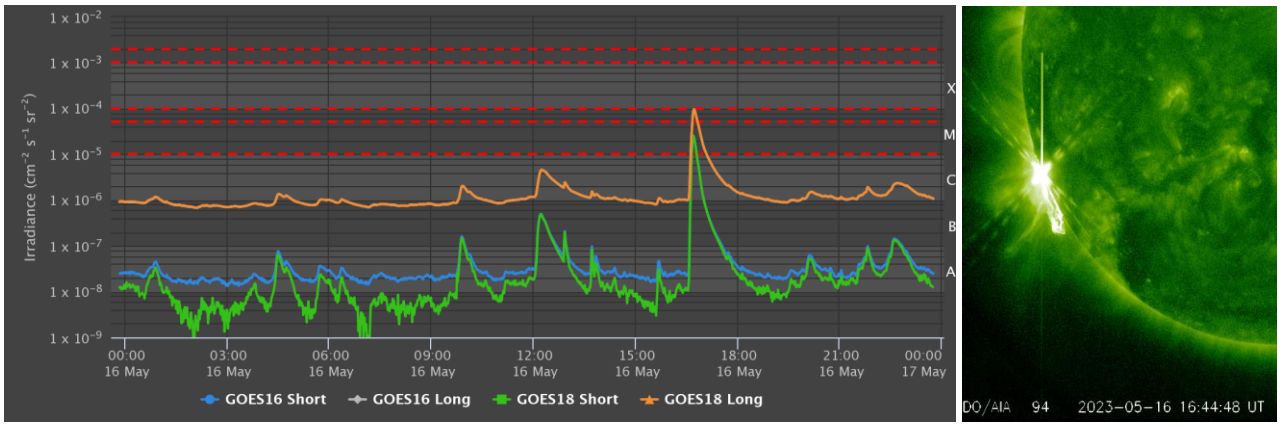
The Penticton 10.7cm flux has been declining throughout the past week, falling from 180sfu on 09 May to reach 135 on 15 May, going some way to confirming that the Sun is undergoing something of a lull in activity, at least on the Earth-facing side.

There are currently six sunspot regions on the visible disc, the majority of which are decaying unipolar or else minor bipolar groups. The one main exception to this remains AR3305, which is the largest, most complex and only spot with any significant growth trend in the past 24 hours. Despite its recent growth, AR3305 has yet to produce significant activity, perhaps because for all its increase in size and number of spots, it remains fairly neatly a straightforward Mt Wilson Beta group.

The balance of front-sided regions is a trade off between the departure of very minor AR3306 and AR3304 in the four days, weighed up against the likelihood of a larger, CME producing region narrowly over the southeast limb at present. With this in mind, the X-ray flare risk is tentatively upwards, albeit to an uncertain degree until any region here presents for analysis.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES X-Ray flares – shows the M9.6 flare at 16/1643 UTC (see SDO/AIA 94 image on the right)



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16 became slightly elevated following the recent M9.6 flare observed at 16/1643 UTC, which originated around the southeast limb. However, the proton flux has remained below the S1/minor threshold.

Ex-3296 is now comfortably over the western solar horizon such that the risk from this spot group can now fade from consideration for the global S1 risks. By far the biggest contributor to the daily risk is now AR3305 given its stature, however it has yet to produce significant flares, let alone proton enhancements. The region yet to emerge from around the southeastern horizon will

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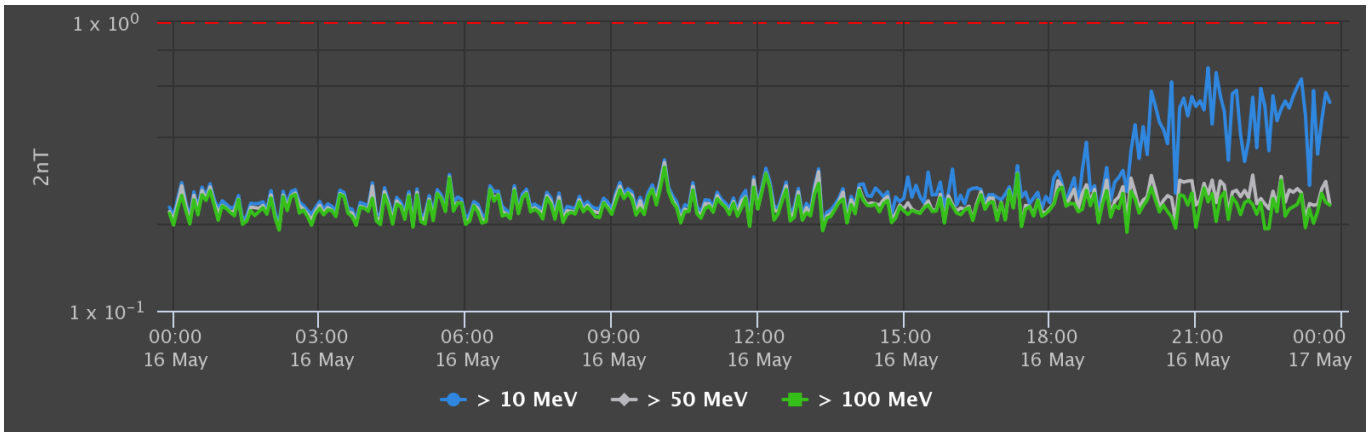
continue to monitored for any further significant flares and proton enhancements, as it continues to rotate onto the disc within the next 24 hours.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES16 Proton Flux – shows slightly elevated at 10MeV after recent M9.6 flare, but remains well below the S1 minor storm threshold.



High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has remained largely at Normal Background levels over the past 24 hours, and this is likely to remain the case through the coming four days in the expected absence of any drivers for increasing counts.The sole coronal hole on the disc, CH03/-, is mooted for a Friday 19 May arrival by MOSWOC Enlil. While this is a persistent feature, its last pass was dominated by a G4 Severe Geomagnetic Storm from a CME, and its predictive value is therefore very limited.

All considered, given the small stature of CH03 and its arrival perhaps not being until day 3 (19 May), any eventual effect on electron flux and fluence ought to fall outside the current four-day period, giving fluence levels comfortably below Active throughout.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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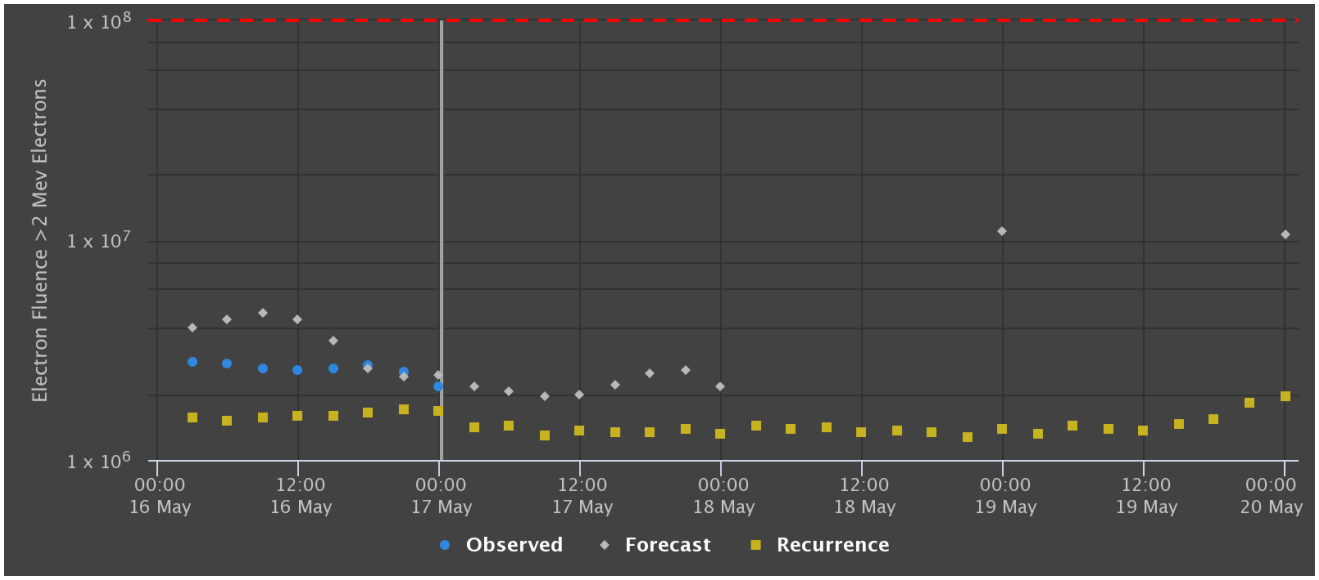
Figure 5: MOSWOC REFM electron fluence.



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